AN OPTIMAL POPULATION REALLOCATION FOR THE POSTWAR SOUTH VIETNAMESE ECONOMY

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THESIS

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for the Postwar South Vietnamese Economy

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ABSTRACT

Present conditions indicate that there will be a severely dislocated and redundant labor force in the postwar South Vietnamese economy. This surplus is the result of abnormally rapid development of some industries which now must face radical changes and the refugees created by hostile activities. To achieve optimal growth, this pool of redundant labor must be reallocated to other sectors of the economy in which productivities are higher. The optimal division of labor after reallocation is estimated by a mathematical model as a function of several exogenous variables. This model also determines the required annual rate of labor absorption for the productive sectors if the reallocation effort is to be successfully completed in a given period of time and under the pressure of natural population growth. The presentation of results is in the form of a computer-based sensitivity analysis. Before reaching conclusions on the feasibility and validity of the results, dynamic programming techniques are suggested as a possible approach in using the reallocation model to forecast economic growth of the postwar South Vietnamese economy.

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I. INTRODUCTION

"Post Viet-Nam." This phrase has many contexts. It has been used to mark the future starting point of a hoped for new era in Vietnamese foreign policy and as a condition precedent to initiating many new domestic and international policies and programs. However, as Kenneth Young noted,[1] a sharp, clear shift from war to peace has appeared increasingly unlikely in recent times, many studies on the economic development of South Viet-Nam have assumptions as to the outcome of the current hostilities.[2] To avoid complications that could possibly arise due to political considerations, this study defines post-war as an era when the war would come to an end in such a manner as to permit development to become a primary objective again, whatever the regime in power.

The war with all of its effects has given the South Vietnamese economy a number of special characteristics that are quite unique and set it aside from the general conditions of other agrarian economies in Asia. To be exact, South Viet-Nam will still be an underdeveloped country and will share the distinctive feature of having a surplus labor

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[1]Kenneth Young, paper presented at the 1970 Conference of the Southeast Asia Development Advisory Group at Belmont, Maryland, October 1970.

[2]Joint Development Group, The Postwar Development of the Republic of Viet-Nam: Policies and Programs, 3 vols., Postwar Planning Group, Development and Resources Corporation, 1969.

force like other underdeveloped economies. However, the South Vietnamese labor surplus is found in its industrial sector and not in agriculture. The reasons for this phenomenon can be traced back to the following two main factors.

A. THE EFFECTS OF HOSTILE ACTIVITIES

The fighting of both sides in the conflict has burdened the South Vietnamese economy with an artificially high degree of urbanization, with the urban population already mounting, by some estimates, to as much as 40 per cent of the total population.[3] The new urban dwellers were in part pushed out of the countryside by war, in part attracted by the new economic opportunity and in part mobilized by military and paramilitary recruiting. A large portion of the uprooted populace are now living in refugee centers and are not contributing to the productive efforts. Many of those who are lucky enough to find the security of the cities also find themselves unemployed or underemployed.

B. THE EFFECTS OF REDUCED U.S. MILITARY PRESENCE

Much of the booming urban activities, especially in the construction and service industries, are directly associated with the war effort and in fact with the U.S. military

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[3]Rand Corporation paper No. P-4569, Imposing Communism on the Ecomony of South Viet-Nam: A Conjectural View, by H. Heymam, Jr., p. 12, January 1971.

presence. Table I records some impact of U.S. military expenditures in recent years on the employment of Vietnamese labor force and their income effects on the economy.

TABLE I

IMPACT OF U.S. MILITARY EXPENDITIURES

	1966	1967	1968	1969	1970
A. Personnel Funded by U.S. Dept. of Defense (in thousands)					
1. Military personnel	358	485	543	543	472
2. Vietnamese employed by U.S. military authorities	76	90	89	93	
3. Vietnamese employed by U.S. contractors to military	58	44	59	46	
4. Total Vietnamese employed in U.S. military sector, 3+4	134	134	148	139	
B. U.S. Defense Expenditures for Goods and Services in Viet-Nam (in million U.S. $)	347	335	341	382	352
C. Equivalence of (B) after income and multiplier effects (in million VN piasters)	74,127	71,289	73,331	83,503	

Source: Buu Hoan, "South Viet-Nam's Economy in Transition," Asian Survey, Vol XI, No. 4, pp. 208-309, April 1971.

As shown in Table I, there are now roughly 150,000 Vietnamese directly employed by the U.S. Armed Forces and their agencies. With the U.S. withdrawal, some will lose their jobs. However, the unemployment problem for these

workers may not be a serious one right now since the country still has to maintain a huge army of more than a million men. Of more devastating consequence is the effect of U.S. withdrawal on the expenditures for goods and expenditures which has been estimated to be somewhere in the range of 20 to 30 percent of the gross national product. These expenditures will no doubt decrease sharply as more and more U.S. troops are withdrawn from Viet-Nam. An immediate consequence of these high rates of expenditure was the development of an abnormally large service sector which in 1969 accounted for 54 percent of GNP, at the expense of the primary and secondary sectors (see Table II). Past policies have favored some particular economic activities in import business and in the supply of goods and services to allied troops and American civilian personnel. The service sector cannot logically

TABLE II

SOUTH VIET-NAM'S GNP BY SECTORS OF ORIGIN

(In percentage of GNP)

	1964	1966	1969
1. Agriculture	28.4	23.4	24.8
2. Industry	12.5	9.6	9.7
3. Services	45.7	55.0	53.7
4. Others	13.4	12.0	11.8

Source: National Bank of Viet-Nam, Estimates of National Income in Viet-Nam, June 1970; USAID/VN, Annual Statistical Bulletin, 1970.

maintain the present high level once the war ends since the demand for this sector will be reduced drastically. The redundant supply of labor will constitute a sizable part in the already existing pool of surplus work force.

Other industries, notably in construction and transportation, will also be affected severely by the U.S. withdrawal. Thanks to the war, the economy of South Viet-Nam has become festooned with vastly overbuilt physical infrastructures - several superbly equipped seaports, fixed and mobile telecommunications networks, rail and air transportation systems. As the war winds down, much of this can be expected to become redundant and so will much of the labor force presently employed in these industries.

The above two observations have served to confirm the fact that at the beginning of the process of economic rehabilitation, South Viet-Nam will be faced with a sizable labor surplus which includes the refugees and redundant labor from certain economic sectors. On the other hand, other sectors like agriculture, manufacturing and light industries, are faced with a labor shortage. One major task of the economic planners will undoubtedly be to reallocate the labor force so as to achieve an optimal growth for the economy. This study is an attempt to solve that problem via a mathematical model of reallocation.

To simplify the terminologies used in the model, let Sector I represent the labor redundant activities and Sector II the labor nonredundant activities. The economy in the

model is treated as being a dualistic economy, having two sectors, one with redundant labor and the other without. The object of this study is to quantify the necessary division of labor between Sectors I and II and to estimate a necessary rate of absorption of labor for Sector II if the optimal reallocation is to be achieved. Once these figures are obtained, this study also suggests how the reallocation model can be used in forecasting economic growth. This can be done by formulating a dynamic programming problem to solve a resource allocation proposition.

Since the need for reallocation of labor has long been recognized by the students of Vietnamese economic development, it should be noted that several writers have published their thoughts on the subject matter.[4] However, most of these writers approached the problem on a policy point of view. As a comparison, this study emphasizes an approach which constructs a theoretical and mathematical model of reallocation and measures the magnitude of the reallocation effort which hopefully will serve as a basis on which future policy measures can be derived.

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[4]See for example:

(a) Joint Development Group, op. cit., ch. 5.

(b) Rand Corporation paper No. P-4563, South Viet-Nam's Development in a Postwar Era: A Commentary on the Three-Lilienthal Report, by A. P. Williams, Jr., January 1971.

(c) Silver, Solomon, "Changes in the Midst of War," Asian Survey, Vol XI, No. 4, pp. 331-340, April 1971.

II. REALLOCATION MODEL

A. THEORETICAL AND GRAPHICAL REPRESENTATION OF MODEL

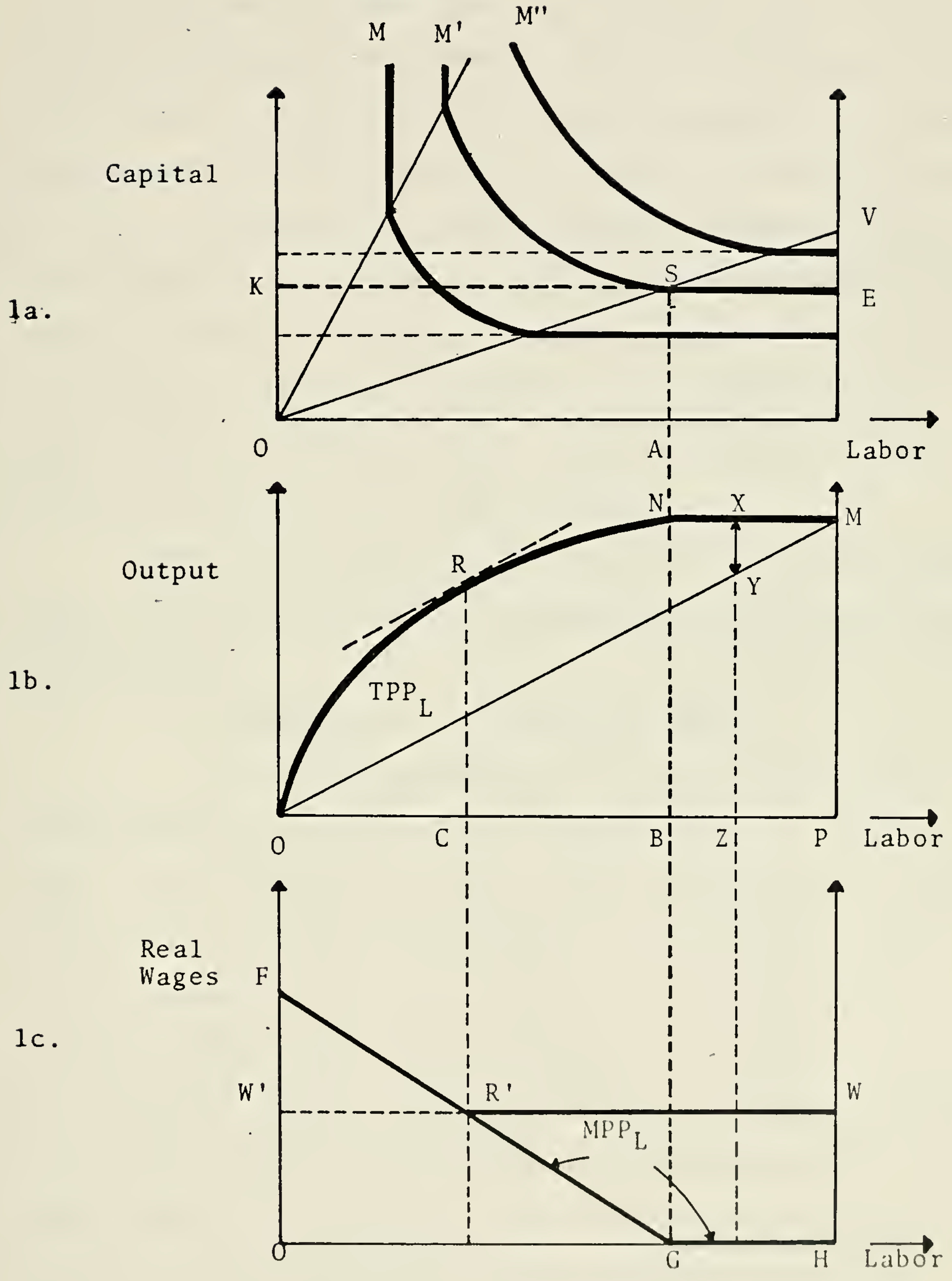
In order to understand how the model is derived, a general description of the present state of Sectors I and II seems necessary.

1. Sector I

The major social problem of the post-war Vietnamese economy is the existence of the so-called over population in this sector. This denotes the persistent pressure of population against scarce resources, mainly capital. To describe the production conditions in Sector I, let the relevant production function be represented in Diagram la. The factors of production used as inputs are labor and capital and the production contour lines are represented by curves M, M', M"... Due to the law of diminishing returns, for a fixed amount of capital there will be a point where any further increase in labor will not result in any increase in output. This phenomenon is represented by segment SE which is the amount of redundant labor in Sector I. Consequently, OA represents the non-redundant labor force. The existence of such a redundant labor force is significant since we have a portion of the population which, while consuming valuable output, is unable to make a productive contribution to it. The major problem before us is the reallocation of such redundant portion of the labor force into alternative employment where they are able to make some positive contribution to total output.

DIAGRAM 1

SECTOR I



When the amount of capital available is fixed, the production conditions above can be pictured also by the curves representing Total Physical Productivity of labor (TPP_L in Diagram 1b) and Marginal Physical Productivity of labor (MPP_L in Diagram 1c). Suppose that OK unit of capital is available, the TPP_L and MPP_L curves are shown in 1b and 1c. Notice that the TPP_L increases at a decreasing rate as the labor force increases, until at point N where TPP_L becomes horizontal. Similarly, the MPP_L gradually decreases as the law of diminishing returns takes effect until at point G where the MPP_L is zero. Note that points S, N, G line up vertically on the three diagrams.

Before going into further details, it is now necessary to introduce some major assumptions upon which the model will be based.

a. Assumption 1: Linearity of MPP_L

The first assumption is that the negatively sloped portion of the MPP_L curve approximates a straight line. This means that the MPP_L curve in Diagram 1c is composed of two straight line segments: a horizontal segment GH and a segment FG for the range of positive marginal physical productivity. This assumption is in fact the price we have to pay in order to achieve a rigorous derivation of the model as will be shown in the mathematical representation. It should be noted that even grossly simple as it may seem to be, this approximation has been used

quite successfully in some empirical studies of real world situations.[5]

b. Assumption 2: Constant Institutional Wage (CIW)

Clearly, if our hypothetical Sector I is commercialized in the sense that it is organized in the form of a competitive market economy, profit maximizing behavior would imply a zero level of real wages (since the MPP_L is zero) for a labor surplus case. However, a zero level of real wages is impossible as it would imply starvation for the workers. One must conclude that competitive conditions do not apply due to the existence of a redundant labor force and the determination of industrial wages must be sought in terms of other institutional forces.

This phenomenon is well recognized in development literature[6] that a hypothesis called the Constant Institutional Wage (CIW) hypothesis is recognized. Under CIW, the real wage level is approximated by the average productivity of labor (APP_L) which is the ratio between the TPP_L and the labor force:

$$APP_L = \frac{MP}{OP} \text{ or the slope of line OM.}$$

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[5]See for instance:
Fei, J. and Ranis, G., Development of the Labor Surplus Economy, p. 221, Richard Irwin, 1964.
Oshima, H., "Underemployment in Backward Economies - An Empirical Comment," Journal of Political Economy, p. 259, June 1958.

[6]Lewis, W.A., "Economic Development with Unlimited Supplies of Labor," in Agarwala, A.N. and Singh, S.P.(eds.), The Economics of Underdevelopment, Oxford University Press, 1954.

In diagram 1c, this real wage level (CIW) is represented by line WW' which is the APP_L.

The acceptance of this CIW hypothesis leads to an important source of capital formation resulting from the population reallocation process which Nurkse called "hidden savings."[7] Suppose that the original labor force in Sector I is OP (Graph 1b) and ZP quantity of redundant labor has been successfully reallocated, the output remains at ZX but now the real wage income of Sector I labor is YZ, a decrease from the previous value of MP.

$$\text{Real wage income} = \text{CIW} \times \text{Total labor force}$$
$$= \frac{YZ}{OZ} \times OZ = YZ.$$

Thus the segment XY represents a "surplus" of goods in Sector I. Note that this surplus is a result of the reallocation of the redundant labor force out of the present unproductive sector and this reallocated manpower and the "surplus" represent the contribution that Sector I makes to the expansion of Sector II.

Another result of the CIW hypothesis is that it permits a prediction on the optimal amount of manpower that needs to be reallocated in order to achieve a balanced growth. Of the present Sector I labor force, only OC of it is used productively since at point C, the MPP_L will equal the CIW. CB units of labor will represent the portion of labor which is underemployed since even when the MPP_L is

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[7]Nurkse, R., Problems of Capital Formation in Underdeveloped Areas, Oxford University Press, 1953.

positive, it is less than the CIW. Any reallocation of labor after it has reached OC will not be beneficial since the MPP_L now exceeds the CIW.

The above simple graphical argument is in fact an illustration of a classical concept in microeconomics which specifies that a condition for optimal production is that the marginal physical productivity must equal the real price of input factors. The main objective of the model is to find out where point C is if all the assumptions are met.

2. Sector II

South Viet-Nam's postwar Sector II production contour map is represented graphically in Diagram 1a in which labor is plotted on the horizontal and capital on the vertical axis. The production contour lines are Q_0, Q_1, Q_2,... The central expansionary role of this sector is symbolically represented by an expansion path o, A_0, A_1, A_2,... representing a gradual expansion of the capital stock K_0, K_1, K_2,..., of Sector II labor force P_0, P_1, P_2,... and of output levels Q_0, Q_1, Q_2,...

An examination of the supply of capital and supply of labor to Sector II will be based on the existence of redundancy in the labor force of Sector I. In fact we may view the latter sector as the chief source of labor supply to the former sector. Market mechanism dictates that Sector II can purchase the services of labor according to a given supply curve whose shape will be determined by the forces operating in Sector I. Such a supply curve is

represented by $EE_0E_1E_2S$ in diagram 2b. It will be noted that the labor supply curve of Sector II has a horizontal portion EE_2 and a rising portion E_2S. The horizontal portion is justified by the fact that the redundant workers in Sector I constitute a potential source of labor supply for Sector II, preventing a rise in real wage. The length of EE_2 will be determined by the amount of redundant labor. At E_2, the redundant labor force will have been reallocated, and in order to attract further supply of labor, the real wage in term of products of Sector II must begin to rise, hence the rising portion E_2S.

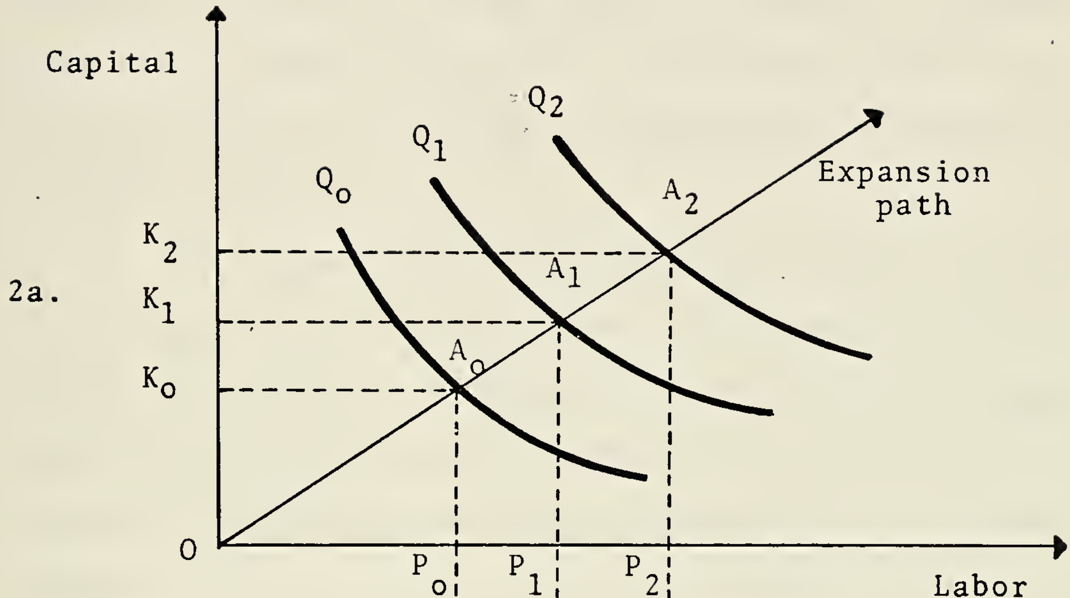
The curves M_0, M_1, M_2,... in diagram 2b are the Marginal Physical Productivity of labor curves corresponding to each amount K_0, K_1, K_2,... of capital stock. Under customary competitive assumptions, these MPP_L curves take on operational significance as the actual demand curves for labor. Consequently, the competitive employment equilibria in labor market are the intersections of these curves with the labor supply curve, i.e. points E_0, E_1, E_2,...

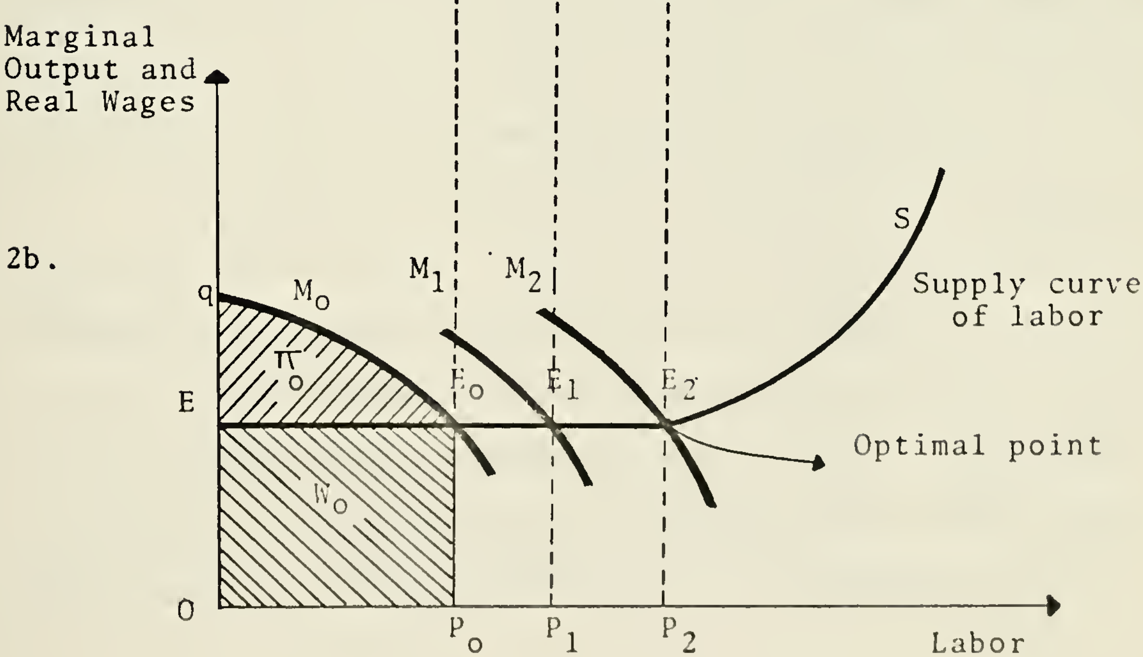
Suppose initially there exists a stock of capital K_0, the equilibrium employment position is then indicated by point E_0. For this short run equilibrium, the profit Π_0 is the shaded area E_qE_0 and the magnitude of total real wage income W_0, the area OEE_0P_0. For illustrative purpose, assume that all profits are saved, then the capital stock for the next period will be:

$$K_1 = K_0 + \Pi_0 + S_0$$

DIAGRAM 2

SECTOR II





Where S_0 is the surplus or "hidden savings" due to the reallocation of OP_0 of the labor force originated from Sector I.

With this new capital stock K_1, a new MPP_L curve is determined, M_1. This determines a new equilibrium E_1 causing an increase in employment of labor by an amount E_0E_1. This amount represents an additional transfer of redundant labor from Sector I to Sector II as a result of capital accumulation.

This recursive process continues until all redundant and underemployed labor has been reallocated and the two sectors can achieve a balanced growth path where investment are allocated optimally to productions in both sectors. The concept of balanced growth will be analyzed in the following section.

This brief graphical analysis of the situation at the beginning of the developing process now permits detailed examination of the main model. To begin, let the two sectors be combined into a more comprehensive representation.

In Diagram 3, the previous Diagrams were reproduced with some modification. Diagram 3a is exactly the same as Diagram 2b. Diagram 3b and 3c are essentially the same as 1b and 1c except that the axis were reversed so that it can be easily seen that a reduction in the present labor force in Sector I is coupled with an increase in the labor force of Sector II. Also a new curve, AS, is introduced, it is

the average surplus curve which is a simple derivation from the idea of "surplus" presented in the previous section.

$$AS = \frac{\text{Total surplus}}{\text{Number of workers reallocated}}$$

When an amount of XC redundant labor force is reallocated, the AS equals the CIW.

$$AS = \frac{YC}{XC} = \frac{OB}{XB} = CIW.$$

After all redundant labor has been reallocated, the AS curve decreases since the total surplus decreases as the result of decreasing total output.

In Diagram 3c, names were given to several points with particular interest to the model:

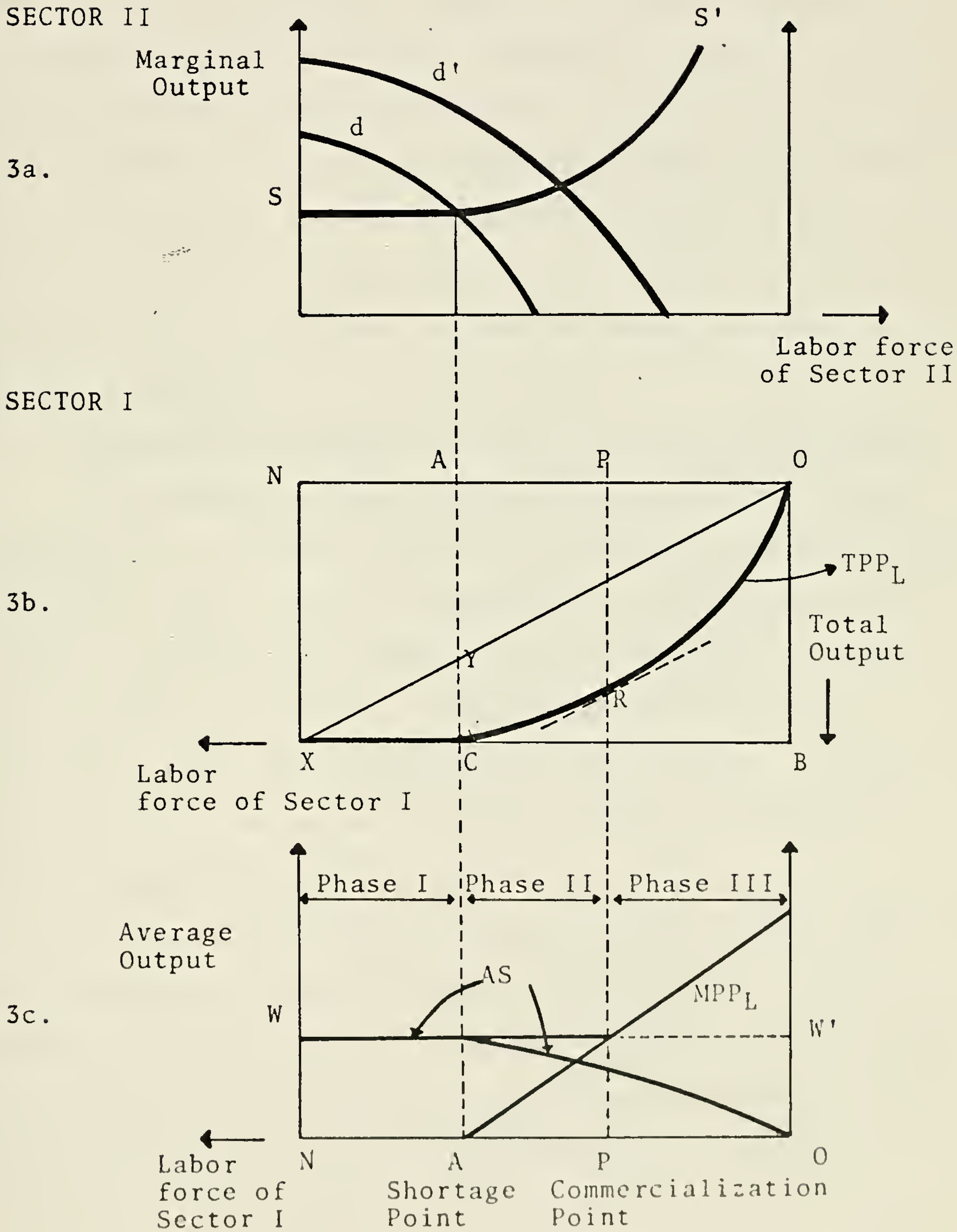
a. The Shortage Point A is where all redundant labor force in Sector I has been reallocated. This phase of reallocation is called Phase I.

b. The Commercialization Point P is where all redundant and underemployed labor has been reallocated. Phase II indicates the reallocation of underemployed labor. The name commercialization comes from the fact that at point P, optimal reallocation has been achieved and now the 2 sectors of the economy begin competing for labor supply.

c. OP or Phase III represents non-redundant labor in the industrial sector. The transition into phase III constitutes a major landmark in the developmental process which this model attempts to reach.

DIAGRAM 3

THE REALLOCATION PROCESS



Up to this point, the simple situation of static output in Sector I and static population has helped identify 3 distinct phases of labor reallocation. This simple situation was reached mainly due to the assumption of a stagnant Sector I side by side with a potentially expanding Sector II. However, it is likely that increases in productivity and employment in Sector I do materialize during the reallocation process. This static condition is now relaxed and a dynamic concept is now introduced which permits productivity in Sector I to change with time. Also at this point, a balanced growth hypothesis defined in terms of intersectoral coordination is also introduced.

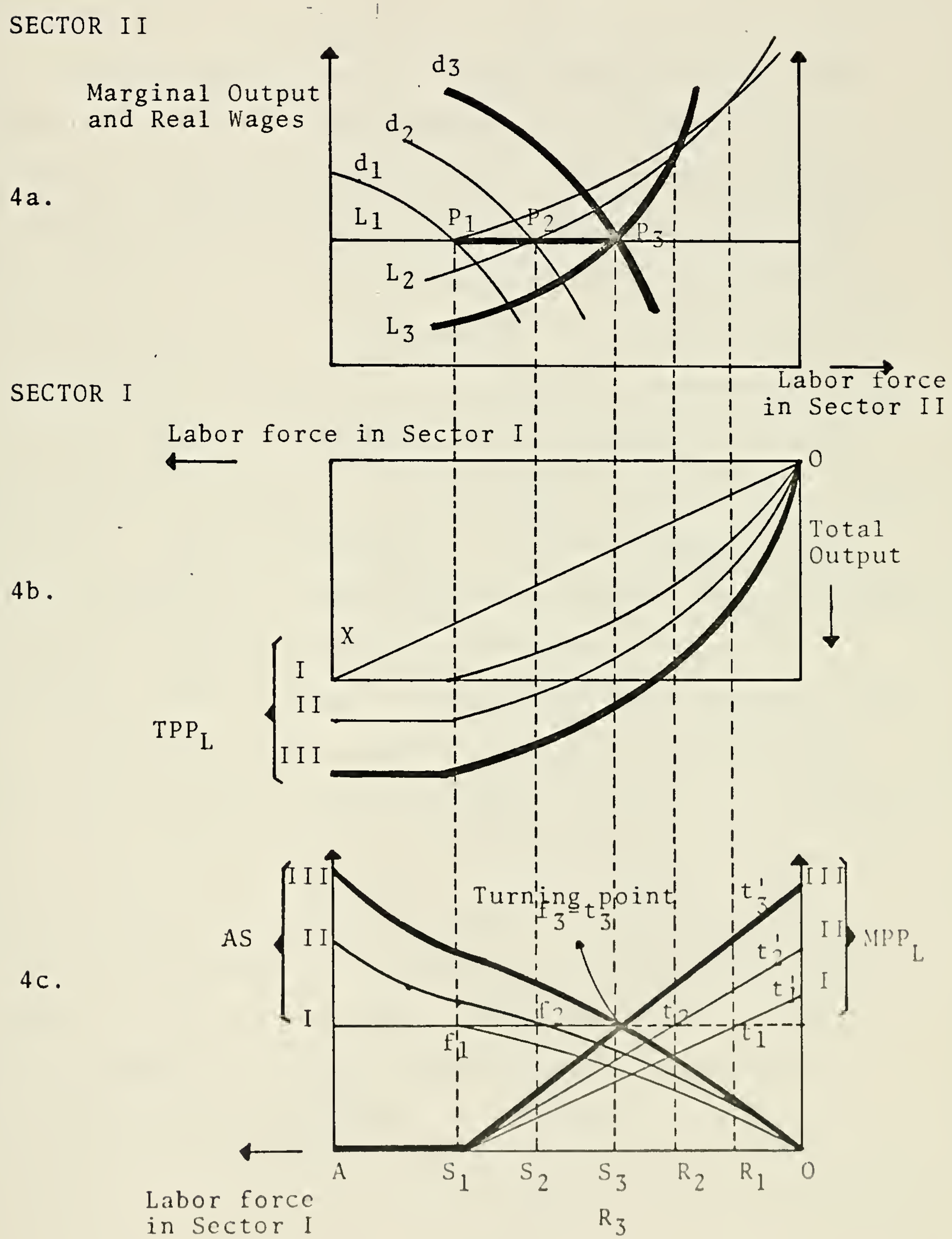
3. Productivity Changes in Sector I and Balanced Growth

An increase in labor productivity of Sector I can be described by an upward shift of the entire total physical productivity (TPP_L) curve of Diagram 3b. Such productivity increases are depicted in Diagram 4b by a sequence of TPP_L curves marked I, II, III,... among which curve I is the initial TPP_L curve as in Diagram 3b, and II, III,... represent the TPP_L curves after successive doses of investment and technological changes in Sector I.

Suppose that as productivity in Sector I increases, the institutional wage CIW remains unchanged, i.e., SA in Diagram 4c equals the slope of OX in Diagram 4b as determined by the initial TPP_L curve. It is of course entirely possible that this institutionally determined wage will increase as

DIAGRAM 4

PRODUCTIVITY CHANGES AND BALANCED GROWTH



productivity in Sector I increases. However, as long as there is a disguised unemployed labor force in this sector, it is reasonable to assume that such upward pressure is not significant.

In Diagram 4c, we plot the sequence of MPP_L curves marked I, II, III,... corresponding to the TPP_L curves I, II, III,... in 4b. According to the static method indicated previously, we can now determine the sequence of shortage points S_1, S_2, S_3,... and the sequence of commercialization points R_1, R_2, R_3,... As in Diagram 4c, for every amount of labor employed in Sector I, an increase in productivity also shifts the MPP_L curve upward. As a consequence, the labor supply curve of Sector I is transformed from $St_1t'_1$ to $St_2t'_2$ to $St_3t'_3$... with a shortening of its horizontal portion. This is equivalent to saying that an increase in productivity of Sector I permits an earlier transition to phase III. Pictorally, the sequence of commercialization points R_1, R_2, R_3,... gradually shifts from right to left. On the other hand, the sequence of shortage points S_1, S_2, S_3... gradually moves from left to right. This is due to the fact that the TPP_L increases as a result of changes in productivity (together with a fixed CIW) produces an increase in the total surplus and hence the average surplus AS. Thus the effect of an increase in productivity of Sector I is an upward shift of the AS curve (from I to II then III...).

Sooner or later, as productivity in Sector I continues to increase, the shortage point and the commercialization point will coincide, i.e., the distance S_1R_1, S_2R_2, S_3R_3... vanishes and phase II is eliminated. In Diagram 4c, such a point of coincidence is described by $R_3 = S_3$. Let this point be called the turning point. Thus there exists one level of productivity in Sector I which brings about such a turning point. It is clear that if productivity increases beyond this turning point level the reallocation process will be reversed, i.e. it will be more profitable to increase the labor force of Sector I.

Now consider the impact of an increase in industrial productivity on the agricultural labor supply curve L_1 in Diagram 4a. On the one hand, the upward shift of the AS curves will shift the labor supply curve of Sector II downward before the commercialization point since an increase in total surplus as a result of reallocation will depress the terms of trade for Sector I and with the constant institutional wage hypothesis the agricultural wage must decline. On the other hand, the upward shift of the MPP_L curves which is accompanied by a higher real wage in Sector I after the commercialization point, raises the supply curve of Sector II after that point. Thus it is easily seen that curve L_2 crosses curve L_1 from below.

It is well known that any analysis of growth in a labor surplus economy must focus not only on the productivity changes in one sector but also on the simultaneous expansion

of the other sector. Successful development requires that productivity changes in the two sectors must depend on each other. What is required is a balance in innovative energies expended together with a balance in the allocation of funds. This general understanding is the central theme of the balanced growth hypothesis advanced by many economists like A. Hirschman[8], Montias[9], and Nurkse[10]. In the context of this model, during the reallocation and growth process, the demand curves for labor d_1, d_2, d_3,... in Sector II gradually shifts upward to the right. simultaneously, innovative activity proceeding in Sector I shifts the supply curves of labor L_1, L_2, L_3,... downward in the same direction. If the economy finds itself, for example, with a demand curve for Sector II labor at d, and a supply curve at L_1 - with OB units of labor already allocated - any movement from equilibrium point P_1 must proceed in a balanced fashion. The economy allocates its investment in part to Sector I, thus raising the productivity of this sector and shifting the supply curve of Sector II to the right, and in part to Sector II, thus raising the capital stock and shifting the demand curve of this sector to the right. It must do so

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[8]Hirschman, A., The Strategy of Economic Development, Yale University Press, 1958.

[9]Montias, J.M., Balanced Growth and International Specialization: A Diagrammatic Analysis, Oxford Economic Papers, June 1961.

[10]Nurkse, R., "Home Investment and External Balance," in Haberler, G. and Stern, R.M. (eds.), Equilibrium and Growth in the World Economy, Harvard University Press, 1961.

in such a fashion that the productivity changes do not substantially alter the intersectoral terms of trade in either direction. If the balanced growth criterion is to be satisfied, the new demand curve d_2 and the new supply curve L_2 must intersect at point P_2 where Sector II will have absorbed P_1P_2 additional workers, which is the same number of workers which has been released by Sector I (distance f_1f_2 in Diagram 4c equals distance P_1P_2 in Diagram 4a). The balanced growth path, hence, is the segment P_1P_3 in Diagram 4a.

The theoretical discussion has been completed and it has paved the way for a rigorous mathematical model which hopefully will provide empirical results to give the future economic planners indications concerning the magnitude of the Vietnamese labor reallocation process.

B. MATHEMATICAL REPRESENTATION OF MODEL

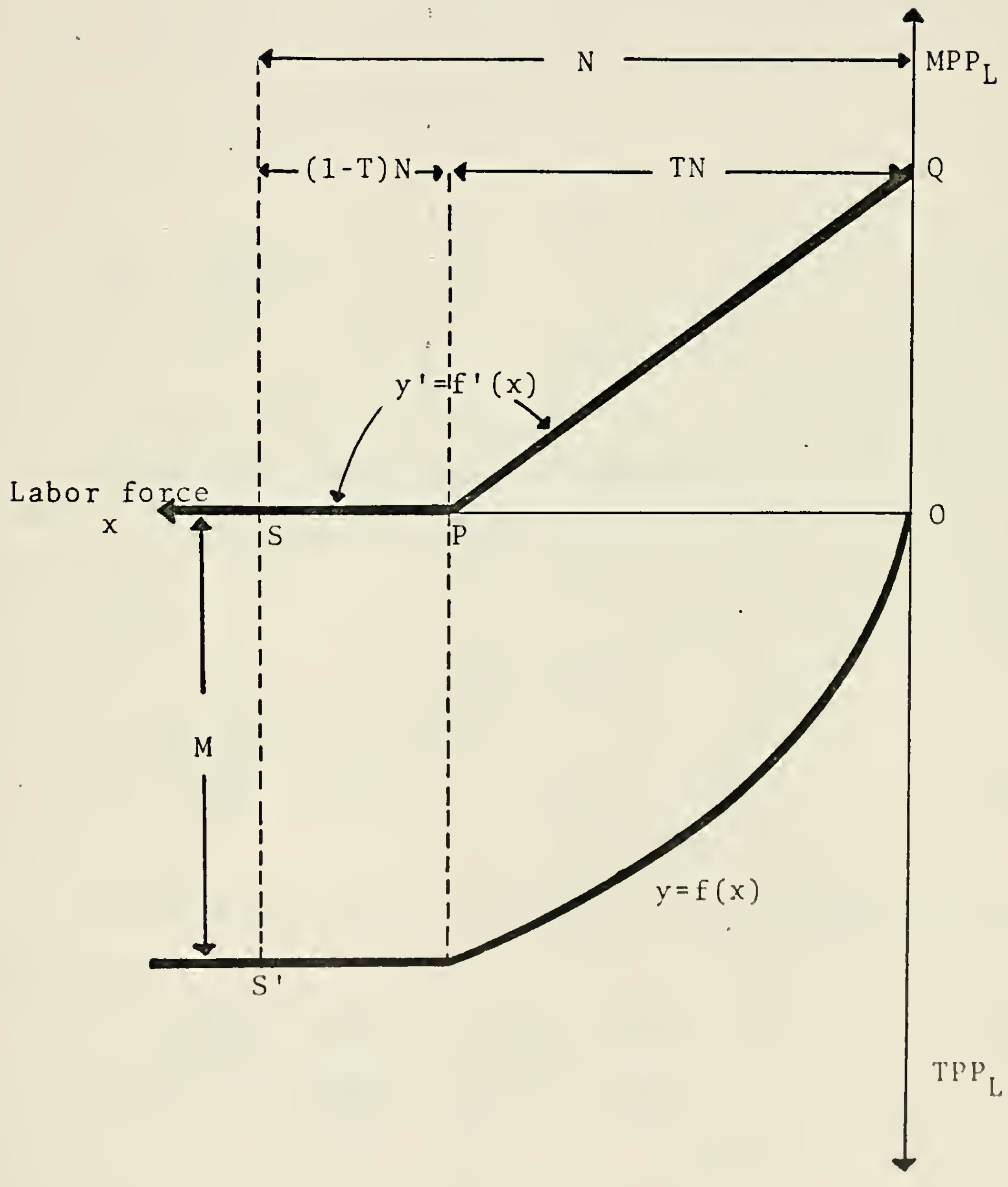
1. Total Product and Marginal Product Functions

In Diagram 5, let point 0 be the origin and let the labor force of Sector I, x, be measured on the horizontal axis to the left of 0. The TTP_L function, $y = f(x)$, and the MPP_L function, $y' = f'(x)$, are measured on the vertical axis, downward for $f(x)$ and upward for $f'(x)$.

Let the initial total labor force be N (located at point S in Diagram 5) and let the total output for Sector I at $x = N$ be M (located at point S'). Let the nonredundant labor force be TN where $0 \leq T \leq 1$ is the nonredundancy coefficient. The definition of the nonredundant labor force is

DIAGRAM 5

TOTAL AND MARGINAL PHYSICAL PRODUCTIVITY CURVES



$f'(x) = 0$ for $x \geqslant TN$. Consequently the redundant labor is $(1 - T)N$.

Assuming that $f''(x) = u$ (the MPP_L function is linear), the TPP_L function must satisfy the following conditions:

a. $f''(x) = u$ for $x < TN$.

b. $f'(x) = 0$ for $x \geqslant TN$.

c. $f(0) = 0$ (TPP_L curve starts from the origin).

d. $f(x) = M$ for $x \geqslant TN$.

e. $f'(x)$ is continuous.

From a and b:

$$\frac{dy}{dx} = \frac{df(x)}{dx} = \begin{cases} ux + a & \text{for } x < TN \\ 0 & \text{for } x \geqslant TN \end{cases} \qquad (1)$$

From e, $u(TN) + a = 0$

Hence $a = -u(TN)$ and (1) becomes:

$$\frac{dy}{dx} = \begin{cases} u(x-TN) & \text{for } x < TN \\ 0 & \text{for } x \geqslant TN \end{cases} \qquad (2)$$

Intergrate the above:

$$y = \begin{cases} u(\frac{x^2}{2} - TNx) + b & \text{for } x < TN \\ c & \text{for } x \geqslant TN \end{cases} \qquad (3)$$

From condition c, $b = 0$ and since e implies $f(x)$ is continuous

$$y = \begin{cases} u(\frac{x^2}{2} - TNx) & \text{for } x < TN \\ c = -u\frac{(TN)^2}{2} & \text{for } x \geqslant TN \end{cases} \qquad (4)$$

From condition d:

$$M = c = -u \frac{(TN)^2}{2}$$

or

$$u = \frac{2M}{(TN)^2}$$

Substituting the value of u into (4):

$$y = \begin{cases} M \left[-\left(\frac{x}{TN}\right)^2 + 2\left(\frac{x}{TN}\right)\right] & \text{for } x < TN \\ M & \text{for } x \geqslant TN \end{cases} \tag{5}$$

Another assumption has to be made at this point.

a. Assumption 3

Pertaining to the discussion of changes in productivity of Sector I, this assumption says that an increase in productivity shifts the entire TPP_L curve upward proportionally. In other words, the new TPP_L curve is obtained by multiplying the initial TPP_L curve by a constant k which will be called the productivity coefficient ($k \geqslant 1$).

With this assumption, equation (5) becomes:

$$ky = f(k,x) = \begin{cases} kM \left[-\left(\frac{x}{TN}\right)^2 + 2\left(\frac{x}{TN}\right)\right] & \text{for } x < TN \\ kM & \text{for } x \geqslant TN \end{cases} \tag{6}$$

From (6), the MPP_L function can now be derived:

$$ky' = \frac{df(k,x)}{dx} = \begin{cases} \left[\frac{2kM}{(TN)^2}\right] [-x+TN] & \text{for } x < TN \\ 0 & \text{for } x \geqslant TN \end{cases} \tag{7}$$

2. <u>Labor Force at the Shortage, Commercialization and Turning Points</u>

Putting Assumption 2 in the context of this mathematical representation:

$$w = \frac{M}{N} \quad \text{and} \quad AS = \frac{ky - xw}{N-x}$$

or

$$AS = \frac{ky - xM/N}{N-x} \tag{8}$$

From the above equations, the shortage point, the commercialization point and the turning point can be derived.

Let

$$V = \frac{x_s}{N}, \quad U = \frac{x_c}{N} \quad \text{and} \quad X^* = \frac{x_t}{N}$$

where x_s, x_c and x_t are the labor force in Sector I at the shortage, commercialization and turning points respectively.

V, U and X* are percentages of the initial labor force undergoing reallocation and 1-X* will represent the optimal portion of labor in Sector II at turning point.

From previous discussion, the shortage point is characterized by having W = AS, the commercialization point by $W = MPP_L$ and the turning point by $W = AS = WPP_L$.

First, express V and U as a function of k:

a. Replacing $x = x_s = VN$ in equation (8) and set AS = W:

$$\frac{M}{N} = \frac{ky - VN\frac{M}{N}}{N-VN}$$

The above reduces to:

$$M = ky$$

Use value of ky in equation (6) in the above gives:

$$M = kM \left[- \left(\frac{V}{T}\right)^2 + 2\left(\frac{V}{T}\right) \right] \tag{9}$$

Solve equation (9) for V;

$$V = V(k) = T\left(1 - \sqrt{1 - \frac{1}{k}}\right) \tag{10}$$

b. Replacing $x = x_c = UN$ in equation (7) for MPP_L and set $MPP_L = W$ gives:

$$\frac{M}{N} = \frac{2kM}{(TN)^2}(-UN + TN) \tag{11}$$

Solve equation (11) for U:

$$U = U(k) = T\left(1 - \frac{T}{2k}\right) \tag{12}$$

c. From previous discussion, at the turning point which comes with a level of k, the shortage point and the commercialization will coincide or $AS = MPP_L$ or $U = V = X^*$. Hence by setting equations (11) = (12), the productivity k of Sector I at optimal reallocation can be found.

$$T\left(1 - \sqrt{1 - \frac{1}{k}}\right) = T\left(1 - \frac{T}{2k}\right) \tag{13}$$

Solve (13) for k:

$$k = \frac{1 + \sqrt{1 + T^2}}{2} \tag{14}$$

Substitute this value of k into either (11) or (12) to get X*:

$$X^* = 1 + T - \sqrt{1 + T^2} \tag{15}$$

Note that X*, the portion of the total labor force remaining in Sector I at the turning point depends only on T, the nonredundancy coefficient. This means that the model is independent of the size of the economy, as reflected by the absolute size of the initial labor force N or the absolute amount of the total output M.

From equation (15), it is readily seen that 1 - X*, the portion of the total labor force in Sector II at turning point, is:

$$1 - X^* = -T + \sqrt{1 + T^2} \qquad (16)$$

C. EXTENSIONS OF THE BASIC MODEL

The main limitations of the previous model lie mainly within assumptions 1 and 3 which were needed for the mathematical derivation. For the purpose indicated, it seems pointless to argue whether these assumptions are justifiable or not. However, the model should be considered as a base to which extensions can be included. One such extension is the problem of population growth and in the same light another extension is discussed in this section.

1. Reallocation Cost

The treatment given the reallocation process in the basic model implicitly assumed that moving workers into another sector did not involve any cost. It is obvious that any resettlement of workers require some expenditures like transportation, training and other overheads. For

illustrative purpose, assume that the reallocation of one worker costs m units of output hence the cost of reallocating x workers is mx. This cost will result in a reduction in the average surplus and this surplus can now be re-written as:

$$AS = \frac{ky - xw}{N-x} - c$$

Using the above equation instead of (8) and go through the derivation again, X* can be found.

With this new extension, X* is no longer independent of M and N, i.e.

$$X^* = X^* (T, M, N)$$

The new value of X* will be larger than the value given by equation (15) and this can be explained by returning to the discussion generated by Diagram 4:

With a lower AS, the demand curves d_i's and supply curves L_i's will shift to the left and the equilibrium points P_1, P_2, P_3,... will also move to the left while they still stay on the balanced growth path. X* which is expressed in Diagram 4c as the ratio OR_3/OA will increase thus signifying that a larger percentage of the labor force will remain in Sector I. Simultaneously, a larger X* or smaller 1-X* indicates that with the inclusion of reallocation cost, the optimal portion of labor force to be in Sector II at turning point is now smaller.

Analytically, direction of change in X* as a function of T follows from equation (15). Take derivative of X* with respect to T:

$$\frac{dX^*}{dT} = 1 - \frac{T}{\sqrt{1+T^2}}$$

Observe that $\frac{dX^*}{dT}$ is always non negative, hence as T increases, X* also increases, 1-X* decreases.

Thus, the effect of reallocation cost is to force some underemployed labor to remain in Sector I at turning point since it would have cost more to reallocate them instead of leaving them in Sector I.

2. The Effect of Population Growth

It is well known that one of the most pressing problems facing any developing economy is population growth. Since this model is considered to apply only for a short period immediately after the war ends when some industrial productivities lag behind agricultural productivity in South Viet Nam, one can argue that the effect of population growth will be minimal if not negligible on the reallocation process. However it is believed that if any modification to the model is desired, one of the first should concern population growth.

Assume that between the beginning and turning point, the economy experiences a population increase of 100r percent as a consequence of natural population growth where r = r(t) is a function of time. The labor force which is a part of

the population also experiences an equivalent increase. Denote the total labor force at turning point as N_t, then

$$N_t = (1 + r(t))N$$

For such an increase in labor force, equation (8) for the average surplus AS becomes:

$$AS = \frac{ky - xW}{N(1+r(t))-x}$$

Use this equation instead of (8) in the derivation and the final result X_t^* is:

$$X_t^* = 1 + \frac{T}{1+r(t)} - \sqrt{1 + \left(\frac{T}{1+r(t)}\right)^2} \qquad (17)$$

Where X_t^* is the labor force remaining in Section I at turning point expressed now as a fraction of N_t.

Assume that labor is actually absorbed by Sector II at a constant annual rate c. The object of this modification is to find c as a function of t where t is the number of years during which the reallocation process is to take place.

To arrive at some concrete result, the behavior of the population growth must be postulated.

a. Assumption 4

The population grows exponentially with time:

$$N_t = e^{rt}N$$

where r is the annual growth rate $\frac{N_i - N_{i-1}}{N_{i-1}}$ which is approximated by a constant.[11]

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[11]This is a familiar assumption in economic growth literature, see for example: Phelph, E.S., Golden Rules of Economic Growth, pp. 92-101, W.W. Norton, 1966.

With this assumption equation (17) becomes:

$$X_t^* = 1 + Te^{-rt} - \sqrt{1 + (Te^{-rt})^2} \qquad (18)$$

Let 1-P be the fraction of the initial labor force N engaged in Sector II, then the actual labor force at time t is:

$$L_A(t) = N(1-P)e^{ct}$$

And using X_t^*, the required labor force in Sector II at time t if the turning point is achieved is:

$$L_R(t) = (1-X_t^*)\ e^{rt}N$$

For a successful reallocation, at time t the actual labor force must equal the required labor force:

$$N(1-P)e^{ct} = N(1-X_t^*)e^{rt} \qquad (19)$$

Solving the above equation for c:

$$c = r + \frac{\ln(1/(1-P))}{t} + \frac{\ln(1-X_t^*)}{t} \qquad (20)$$

From (18) and (20), the annual labor absorption rate c can be determined for a given value of t or if c is given, the required time to complete the reallocation process t can be computed.

Both X_t^* and c are functions of T and in order to obtain any results from the model, an operational definition for T must be constructed. In words, T actually is the portion of labor which, given a level of capital, can possibly

be employed to increase output and any further addition of labor beyond T does not result in an increase in output. Even with a stagnant Sector I, the true level of T is difficult to measure, however, given the assumptions of this model, T - as a first approximation - can be defined to satisfy

$$TN = \text{Number of employed workers in Sector I.}$$

III. DATA AND RESULTS

Since the primary application of this study lies in the future when the war in South Vietnam ends or at least all hostile activities cease and the process of economic development is not obstructed, actual data are not available in any exact sense. The input data for the model will be T, P, r and t.

The operational definition of T has been given and measurements for T and P should be simple once the war ends; even if statistics are not available, statistical methods will yield estimates with no difficulty. However to postulate when the war will end is entirely superficial. The time period of planning is a matter of policy and with it a certain degree of subjectivity beyond the scope of this study. Right now, only the measurement for r, the natural rate of population growth lends itself to statistical estimates since it does not depend on when the war ends. Using United Nations data[12] and since no assumption was made on the distribution of r, a nonparametric test - the Wilcoxon Signed Rank[13] - was used to obtain a 90 percent confidence interval for r:

$$.0208 \leqslant r \leqslant .0248.$$

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[12] United Nations, Economic Survey of Asia and the Far East 1970, p. 218, 1971.

[13] Conover, W.J., Practical Nonparametric Statistics, pp. 206-222, John Wiley, 1971.

The best we can do under the circumstances is a sensitivity analysis which will study X* and c as a function of T, P, r and t. A computer program - see appendix - was written for this purpose and it was designed to accommodate all theoretical ranges for T, P, r and t

$$0 \leqslant T < \infty$$

$$0 \leqslant P \leqslant 1$$

$$0 \leqslant r \leqslant 1$$

$$0 \leqslant t < \infty$$

Note that the operational definition for T limits its value to within the range from 0 to 1. Results for some selective values of the above variables are represented in Tables III, IV and V.

TABLE III

ALLOCATION OF LABOR FORCE AT TURNING POINT

WITH CONSTANT POPULATION

T	.30	.40	.50	.60	.70
X*	.2560	.3230	.3820	.4338	.4793
1-X*	.7440	.6770	.6180	.5662	.5207

From Table III, for each value of T one can find the corresponding percentages for X* and 1-X*. For example, if T is .50, the optimal allocation of labor at turning point is 38.2 percent of the total labor force to remain in Sector I and 67.7 to be in Sector II. Computations for this table are based on equations (15) and (16) of the basic model.

TABLE IV

ALLOCATION OF LABOR FORCE AT TURNING POINT

WITH CONSTANT POPULATION GROWTH RATE

t=5 years	T	.30	.40	.50	.60	.70
R=.0208	X*	.2345	.2975	.3538	.4039	.4485
	1-X*	.7655	.7025	.6462	.5961	.5515
R=.0248	X*	.2305	.2928	.3485	.3982	.4426
	1-X*	.7695	.7072	.6515	.6012	.5574

Table IV represents X* and 1-X* as a function of some selective values of t, R and T. A comparison with Table III indicates that with the pressure of population growth, the percentage of labor remaining in Sector I is relative lower than the case where no population growth is allowed. The reduction in percentage is due to the fact that additional labor as a result of natural growth must also be absorbed by Sector II before turning point is reached. The computations for Table IV are based on equation (18) in the extension of the basic model.

Table V gives value of the required annual rate of labor absorption c if the reallocation process is to be completed in 5 years. For example, if T = .50, P = .60 and r = .0228 then n = .1196. In words, if the nonredundancy coefficient is 50 percent, the initial portion of labor in Sector I is 60 percent of the total labor force and the rate of population growth is 2.28 percent, then

TABLE V

REQUIRED ANNUAL RATE OF LABOR ABSORPTION OF SECTOR II

AS A FUNCTION OF T, P, r, t

t = 5 years

			T				
			.20	.40	.50	.60	.70
P=.50	r	.0208	.1060	.0888	.0721	.0560	.0404
		.0218	.1073	.0901	.0735	.0574	.0419
		.0228	.1085	.0915	.0749	.0589	.0435
		.0238	.1098	.0928	.0763	.0604	.0450
		.0248	.1196	.0942	.0777	.0618	.0465
P=.60	r	.0208	.1506	.1334	.1167	.1006	.0850
		.0218	.1519	.1348	.1181	.1021	.0866
		.0228	.1531	.1361	.1196	.1035	.0881
		.0238	.1544	.1374	.1210	.1050	.0896
		.0248	.1557	.1388	.1224	.1065	.0912
P=.70	r	.0208	.2082	.1910	.1743	.1581	.1426
		.0218	.2094	.1923	.1757	.1596	.1441
		.0228	.2107	.1936	.1771	.1611	.1456
		.0238	.2119	.1950	.1785	.1625	.1472
		.0248	.2132	.1963	.1799	.1640	.1487

each year Sector II has to increase its labor force by 11.96 percent in order to absorb all redundant and underemployed workers of Sector I and neutralize the effect of population growth in 5 years.

The length of planning period, hence, reflects the ambitiousness of government policies. A shorter planning period requires a higher rate of absorption while a longer period requires a lower c.[14] Consequently, in setting a target date for the completion of the reallocation process, an economic planner must take into account the physical abilities of the economy to absorb new labor effectively; otherwise it would be a case of moving redundant labor from one sector to another sector where they are also redundant.

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[14]For the same values of T=.50, P=.60, r=.0228, but if the planning period is 10 years, then the required annual rate of labor absorption is only 7.56 percent as opposed to 11.96 percent if t is 5 years.

IV. USE OF REALLOCATION MODEL IN ECONOMIC PLANNING

As stated in the introduction, the main purpose of the model is to achieve an optimal use of labor in the process of economic development or in other words, to achieve an optimal growth rate for the economy. Assume that the reallocation model is accepted and the rate of labor absorption for Sector II is used as a policy then how can this rate be used in economic planning?

Let the Gross National Product be the index of growth then in a dualistic economy:

$$GNP_t = Q_{1t} + Q_{2t}$$

where Q_{1t} and Q_{2t} are the respective total outputs of Sectors I and II in year t.

Q_{1t}, the total output of the labor redundant sector is measured by equation (6) in the basic reallocation model where all terms are now known.

Q_{2t} is further divided into subsectors which can be generalized as the agricultural sector and industrial sector which now absorb the reallocated labor from Sector I. Assume now that Q_{2t} can be approximated by a Cobb-Douglas type production function:[15]

$$Q_{2t} = Q_{At} + Q_{It}$$

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[15] Tinbergen, J. and Bos, H., Mathematical Models of Economic Growth, p. 32, McGraw-Hill, 1962.

where Q_{At} is the output of the agricultural sector and can be approximated by:

$$Q_{At} = k_A \ (1 + \varepsilon_A)^t \ K_{At}^{\alpha_A} \ L_{At}^{\beta_A}$$

where k_A is a constant

ε_A is the annual rise in efficiency

L_{At} is the labor quantity employed in year t

K_{At} is the capital quantity used in year t

α_A and β_A are the elasticities of production with regard to capital and labor respectively.

The Cobb Douglas type function comes as a result of possible input factors substitutability. In this case labor and capital can substitute for each other in the production process due to the fact that labor is nonredundant in Sector II which agriculture constitutes one part.

Similarly for the industrial part in Sector II, Q_{It} can also be approximated:

$$Q_{It} = k_I \ (1 + \varepsilon_I)^t \ K_{It}^{\alpha_I} \ L_{It}^{\beta_I} \quad .$$

Statistical estimates can be applied to find k_A, ε_A, α_A, β_A, k_I, ε_I, α_I and β_I.

A logarithmic transformation of Q_A and Q_I gives:

$$\ln Q_{At} = \ln k_A + \alpha_A \ln K_{At} + \beta_A \ln L_{At} + t \ \ln(1+\varepsilon_A)$$

$$\ln Q_{It} = \ln k_I + \alpha_I \ln K_{It} + \beta_I \ln L_{It} + t \ \ln(1+\varepsilon_I)$$

The above equations are linear in their logarithmic transformation and hence with historical data, a multivariable

linear regression[16] can be performed to estimate the coefficients.

$$Q_{At} = f(L_{At}, K_{At}, t)$$

$$Q_{It} = f(L_{It}, K_{It}, t)$$

The effect of the reallocation model is to provide a constraint for L_{At} and L_{It}; knowing the annual rate of labor absorption c, the labor force for Sector II can be computed once t is given.

$$L_t = e^{c(t-1)} L_o \quad , \quad t = 2, 3, \ldots$$

where L_o is the labor force in Sector II at the beginning of the planning period (L_o = PN in model).

Assume further that there is available in year t a capital stock K_t to be used in economic development for Sector II. The problem of maximizing growth can now be formulated as follows:

$$\text{Max GNP} = Q_{1t} + Q_{At} + Q_{It}$$

$$\text{Subject to} \quad L_{At} + L_{It} = L_t$$

$$K_{At} + K_{It} = K_t$$

$$L_{At}, L_{It}, K_{At}, K_{It} \geq 0$$

The problem can be solved by several methods to find the optimal allocation of labor and capital to be used in the agricultural and industrial subsectors of Sector II. Dynamic

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[16] Theil, H., Principles of Econometrics, chapter 3, pp. 101-155, John Wiley, 1971.

programming seems to be best technique to solve this problem since it opens the way to several important generalizations.

To illustrate this technique,[17] consider the problem in its first year of the planning period:

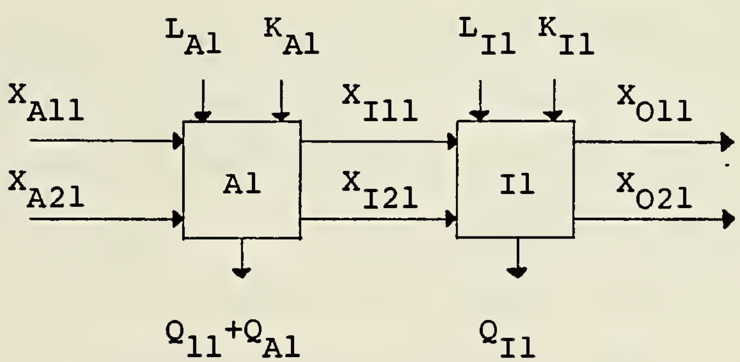
$$\text{Max } Q_{11} + k_A \ (1+\varepsilon_A) \ K_{A1}^{\alpha_A} \ L_{A1}^{\beta_A} + k_I \ (1+\varepsilon_I) \ K_{I1}^{\alpha_I} \ L_{I1}^{\beta_I}$$

Subject to $\quad K_{A1} + K_{I1} = K_1$

$$L_{A1} + L_{I1} = L_1$$

$$L_{A1}, L_{I1}, K_{A1}, K_{I1} \geqslant 0$$

Transform this into a 2 stage dynamic programming problem with 2 state variables and 2 decision variables. A and I are the two stages, K and L are the two decision variables and the returns are $Q_{11} + Q_{A1}$ and Q_{I1}.



Introduce the state variables X_{11}, X_{21} the constraints for the dynamic programming problem becomes:

$$X_{A11} = L_1$$

$$X_{A21} = K_1$$

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[17] Nemhauser, G.L., Introduction to Dynamic Programming, John Wiley, 1966.

$$X_{I11} = X_{A11} - L_{A1} \geqslant 0 \quad \rightarrow \quad X_{A11} \geqslant L_{A1}$$

$$X_{I21} = X_{A21} - K_{A1} \geqslant 0 \quad \rightarrow \quad X_{A21} \geqslant K_{A1}$$

$$X_{O11} = X_{I11} - L_{I1} = 0$$

$$X_{O21} = X_{I21} - K_{I1} = 0$$

Hence the recursive equations are:

$$f(X_{I11}, X_{I21}) = \max_{\substack{X_{I11} = L_{I1} \\ X_{I21} = K_{I1}}} Q_{I1}$$

$$f(X_{A11}, X_{A21}) = \max_{\substack{0 \leqslant L_{A1} \leqslant X_{A11} \\ 0 \leqslant K_{A1} \leqslant X_{A21}}} \{Q_{11} + Q_{A1} + f(X_{I11}, X_{I21})\}$$

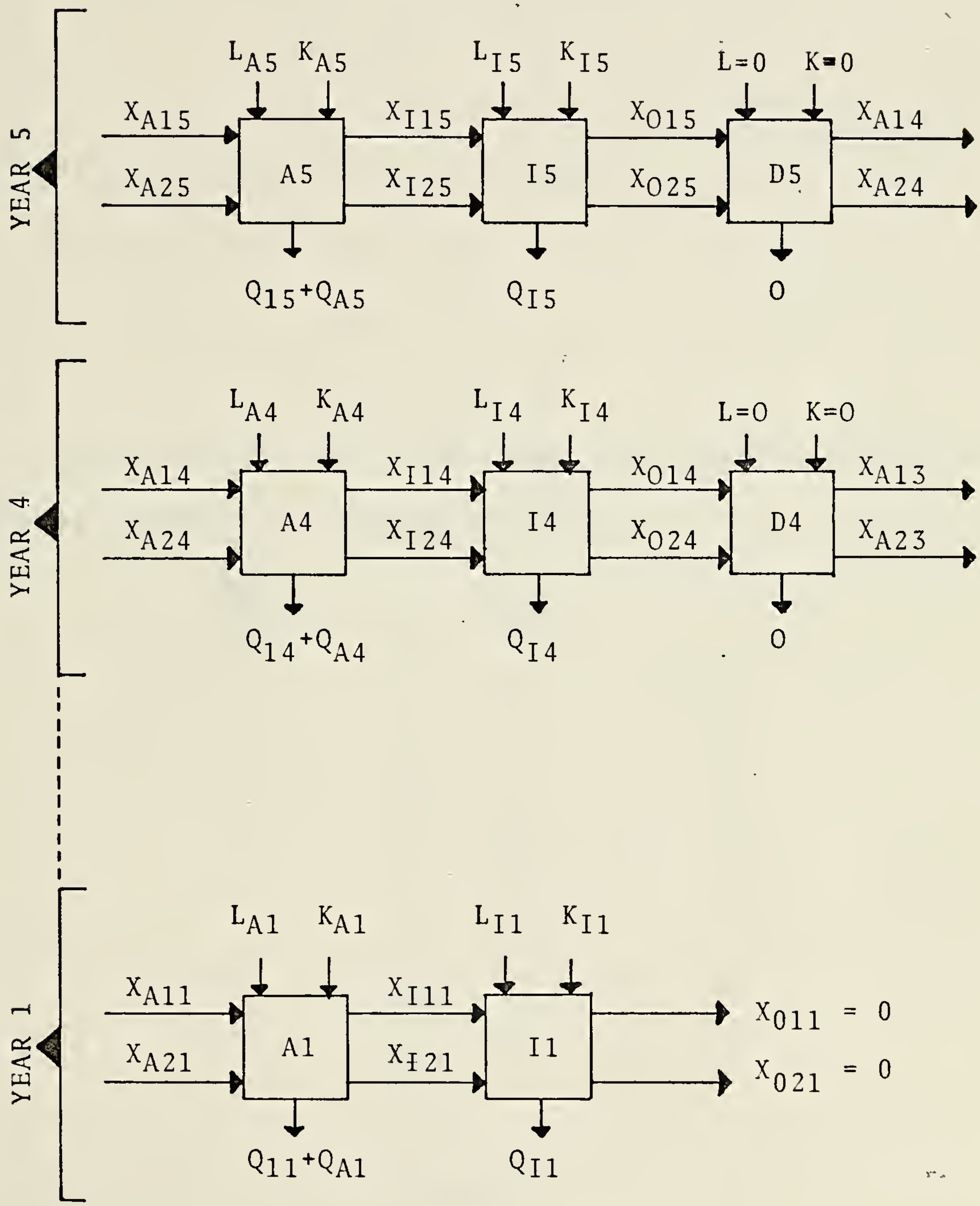
$f(X_{A11}, X_{A21})$ is the solution to GNP of the first year of the planning period.

Extend the problem now to include all t years of the planning period. In order to preserve continuity, add a dummy stage for each year (except the first) in which the decision variables are zeros, the return is zero and the state variables assume values K_t, L_t, $t = 2, 3, \ldots$

Thus for a planning period of 5 years for example, the problem has 14 stages and can be represented graphically in Diagram 5. Recursive equations and maximizing technique are similar to the ones developed for year 1 above:

DIAGRAM 6

DYNAMIC PROGRAMMING FORMULATION



$$f(X_{A1t}, X_{A2t}) = \max \{Q_{1t} + Q_{At} + f(X_{I1t}, X_{I2t})\}$$

$$0 \leqslant L_{At} \leqslant X_{A1t}$$

$$0 \leqslant K_{At} \leqslant X_{A2t} \qquad t = 1, \ldots, 5$$

$$f(X_{I1t}, X_{I2t}) = \max \{Q_{1t} + f(X_{A1t-1}, X_{A2t-1})\}$$

$$0 \leqslant L_{At} \leqslant X_{A1t}$$

$$0 \leqslant K_{At} \leqslant X_{A2t} \qquad t = 2, \ldots, 5$$

$$f(X_{O1t}, X_{O2t}) = f(X_{A1t-1}, X_{A2t-1}) \qquad t = 2, \ldots, 5$$

$$f(X_{I11}, X_{I21}) = \max \quad Q_{I1}$$

$$X_{I11} = L_{I1}$$

$$X_{I21} = K_{I2}$$

The above recursive equations lead to solution of the general dynamic programming problem:

$$\max \sum_{t=1}^{5} \left(Q_{1t} + Q_{At} + Q_{It} \right)$$

subject to

$$X_{A1t} = L_t \qquad t = 1, \ldots, 5$$

$$X_{A2t} = K_t \qquad t = 1, \ldots, 5$$

$$X_{I1t} = X_{A1t} - L_{At} \qquad t = 1, \ldots, 5$$

$$X_{I2t} = X_{A2t} - K_{At} \qquad t = 1, \ldots, 5$$

$$X_{O1t} = X_{I1t} - L_{It} = 0 \qquad t = 1, \ldots, 5$$

$$X_{O2t} = X_{I2t} - K_{It} = 0 \qquad t = 1, \ldots, 5$$

All $X_{\ldots}$, $L_{.}$, $L_{..}$, $K_{.}$, $K_{..}$, are non negative

Further extension of this approach can be accommodated for the case when Q_{2t} are broken not into 2 subsectors but several subsectors representing more detailed break down of productive activities. If Q_{2t} are broken into J subsectors, then the dynamic programming problem has $(J+1)t - 1$ stages with 2 state variables and 2 decision variables, one for labor and one for capital. There are existing computer programs[18] to solve dynamic programming problem and these can be applied to derive results with little difficulty. In addition, the above basic dynamic programming problem can be extended to have converging and diverging branches at each stage to accommodate assumptions about the K_t or solving several resource allocations within the basic resource allocation problem.

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[18] One of these programs is available at the Naval Postgraduate School, Monterey, library under the name DYNAMI4.

V. CONCLUSION

Accounts of the destructive effects of the war in South Viet-Nam are well publicized. Yet in the midst of the fighting, fundamental social and economic changes have taken place and willingly or not, they will have brought profound modifications to the structure of society. Curiously enough, in the opinion of several economic analysts, these changes will benefit future development of the economy. As Solomon Silver observed,

> "It is paradoxical that while the war limited economic growth and development, it also brought about conditions necessary to exert a favorable influence on economic development and growth in the years ahead."[19]

Even when there are indeed grounds for optimistic projections in the future, most studies, however, strongly associate the degree of success in economic recovery to the amount of foreign assistance to South Viet-Nam in the future, at least for a short period. Given the present dependency on the U.S., in the future, South Viet Nam will sorely need foreign aid in the form of technical assistance, capital assistance and balance of payments support.

In the context of the reallocation model, it seems safe to predict that the labor force in Sector II will have to

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[19] Solomon Silver, op.cit. p. 331. In his article, Silver analyzed several changes that will have positive effects on future development.

increase by over 10 per cent annually to absorb all redundant labor in Sector I in a 5 year period. In order to avoid shifting redundant labor in one sector to become redundant in another, capital is needed and it is needed in no small measure. The Thuc-Lilienthal Report, for example, estimated that Viet-Nam will need about U.S. $2.5 billion in foreign aid for the 10 year period after the hostilities cease and even that figure is considered conservative.[20]

To avoid capital intensive development activities, it is suggested that the redundant labor from Sector I be shifted back primarily to agriculture. Normally in an agricultural and underdeveloped economy, the cultivable acreage is assumed to be limited and due to this limit, the terms of trade with respect to the industrial sector is usually poor and a certain degree of industrialization is required to achieve a take off point for economic development. This argument is simply not applicable to the postwar Vietnamese economy, at least for a short period of time after the war ends. South Viet-Nam is traditionally a rice exporting area and peak production came at about 1940, just prior to World War II. From 1963 to 1967, farm production fell 24 per cent; land planted to rice decreased by over half a million acres and rice production dropped from 5.3 million tons to 4.3 million tons.[21] Even data for recent

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[20] Albert P. Williams, Jr., op. cit. p. 24.

[21] Logan, W.J.C., "How Deep is the Green Revolution in South Viet-Nam," Asian Survey, Vol XI, No. 4, p. 322, April 1971.

years are not yet available, further reduction seems certain as a result of the 1968 and 1972 communist offensives. All this argument points to the fact that when the war ends, agriculture is a potentially rapid growing sector since its production involves not innovation but rehabilitation. Data from the rehabilitation period of 1954-1960 confirm this fact.[22]

In addition, it was estimated that 75 percent of the refugees - the main source of labor surplus - will return to their lands if sufficient financial assistance is given them.

All indications seem to point to the fact that the greatest demand for labor will be in agriculture. Forest resources may also provide a potential source of employment but it is unlikely that industry will be a significant employment source in the immediate post war period; the Joint Development Group went as far as suggesting that the main industrial development effort in the recovery period be directed at reconstruction and repair of industrial installations, bringing into production half completed projects, and the revival of depressed industries with the highest priority given to the production of inputs to the agricultural sector.[23]

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[22] Sansom, R.L., The Economics of Insurgency in the Mekong Delta of Viet-Nam, p. 22, M.I.T. Press, 1970.

[23] Joint Development Group, op. cit. ch. 9.

Taking all of the above argument into account, a target growth of between 10 and 20 percent annually of Sector II labor force in the reallocation model is not entirely out of reach for the postwar Vietnamese economy.

Finally, a note of caution should be sounded on the availibility and reliability of data in South Viet-Nam. As Gunnar Myrdal observed on the economic realities of under-developed economies:

> "The attempt to sketch economic reality, to find out what the present situation is and discern dominant trends, is severely restricted by the lack of precise and reliable statistics and other information. Even more fundamentally, we are restricted by inconsistent, unrealistic, and even misleading concepts in attempting to grasp and interpret the facts."[24]

Viet-Nam is no exception to the rule, especially the reliability of data available is a serious question due to the war and the lack of experienced statisticians. The validity of the reallocation model in particular and economic planning in general will depend to a large extent on the gap between available information and reality.

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[24] Myrdal, G., Asian Drama, An Inquiry into the Poverty of Nations, vol I, p. 411 Pantheon, 1968.

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***********************************
PROGRAM FOR SENSITIVITY ANALYSIS OF
      REALLOCATION MODEL
***********************************


EXPLANATION OF SYMBOLS

   1. EXOGENOUS VARIABLES

     T  :  NONREDUNDANCY COEEFICIENT
     P  :  PORTION OF LABOR FORCE IN SECTOR I AT THE
           BEGINNING OF PLANNING PERIOD
     R  :  NATURAL POPULATION GROWTH RATE
     NYEARS  :  LENGTH OF PLANNING PERIOD IN YEARS

   2. ENDOGENOUS VARIABLES

     X   =  F(T)  :  PORTION OF LABOR FORCE REMAINING IN
                     SECTOR I AT TURNING POINT,
                     GIVEN CONSTANT POPULATION
     CX   =  F(T)  :  PORTION OF LABOR FORCE REMAINING IN
                      SECTOR II AT TURNING POINT,
                      GIVEN CONSTANT POPULATION
     XPOP   =  F(T,R,NYEARS)  :
               PORTION OF LABOR FORCE REMAINING IN
               SECTOR I AT TURNING POINT
               GIVEN POPULATION GROWTH RATE R
               AND A PLANNING PERIOD OF LENGTH NYEARS
     CXPOP   =  F(T,R,NYEARS)  :
                PORTION OF LABOR FORCE REMAINING IN
                SECTOR II AT TURNING POINT
                GIVEN POPULATION GROWTH RATE R
                AND A PLANNING PERIOD OF LENGTH NYEARS
     C   =  F(T,P,R,NYEARS)  :
            REQUIRED ANNUAL RATE OF LABOR ABSORPTION OF
            SECTOR II AS A FUNCTION OF T,P,R,NYEARS.

INPUT DATA CARDS

   FIRST DATA CARD   :  NUMBER OF RUNS DESIRED
   SECOND DATA CARD  :   10 VALUES OF T
   THIRD DATA CARD   :  5 VALUES OF P
   FOURTH DATA CARD  :   5 VALUES OF R
   FIFTH DATA CARD   :  2 VALUES OF NYEARS

   REPEAT DATA CARDS 2,3,4 AND 5 WITH DIFFERENT INPUT
   VALUES THE EXACT NUMBER OF RUNS DESIRED.


**********************MAIN PROGRAM**********************


#HUNG0215 WATFORG (0215,1033WT,ROZ0),'HUNG'
$JOB  (0215.1033WT.ROZ0).'HUNG'
      DIMENSION T(10),P(5),R(5),NYEARS(2),X(10),CX(10),
     X          C(10,5,5,2),XPOP(10,5,2),CXPOP(10,5,2)
C
C               READ INPUT DATA
C
      READ,N
      DO 2000 M=1,N
      READ,(T(I),I=1,10)
      READ,(P(I),I=1,5)
      READ,(R(I),I=1,5)
      READ,(NYEARS(I),I=1,2)
C
C               COMPUTATION OF X AND 1-X
C
      DO 1 I=1,10
      X(I)= 1+T(I)-SQRT(T(I)*T(I)+1)
      CX(I)=1-X(I)
```

```
 0001 CONTINUE
C
C          COMPUTATION OF C AS A FUNCTION OF T,P,R,NYEARS
C
      DO 2 I=1,10
      DO 4 K=1,5
      DO 5 L=1,2
      XPOP(I,K,L)=1+(T(I)*EXP(-R(K)*NYEARS(L)))
     X       -(SQRT(1+(T(I)*EXP(-R(K)*NYEARS(L)))**2))
      CXPOP(I,K,L)=1-XPOP(I,K,L)
      DO 3 J=1,5
      C(I,J,K,L)=R(K)+ALOG(1/(1-P(J)))/NYEARS(L)
     X             +ALOG(CXPOP(I,K,L))/NYEARS(L)
 0003 CONTINUE
 0005 CONTINUE
 0004 CONTINUE
 0002 CONTINUE
C
C             OUTPUT
C
      WRITE(6,1000) (T(I),I=1,10),(X(I),I=1,10),
     X              (CX(I),I=1,10)
 1000 FORMAT(' ',///,30X,'PERCENTAGE OF LABOR FORCE'/,30X
     X      ,'IN SECTORS I AND II AT TURNING POINT'/,30X,
     X       'GIVEN CONSTANT POPULATION'////,10X,'T:',5X,
     X       10F10.4//,10X,'X:',5X,10F10.4//,
     X       10X,'1-X:',3X,10F10.4///)
      DO 9 L=1,2
      WRITE(6,1001) NYEARS(L)
 1001 FORMAT(' ',//,30X,'PERCENTAGE OF LABOR FORCE'/,30X,
     X       'IN SECTORS I AND II AT TURNING POINT'/,30X,
     X       'GIVEN A POPULATION GROWTH RATE'/,30X,
     X       'AND A PLANNING PERIOD OF',I4,2X,'YEARS'////)
      WRITE(6,1002) (T(I),I=1,10)
 1002 FORMAT(' ',20X,'T:',8X,10F8.4///)
      DO 10 K=1,5
      WRITE(6,1006) R(K),(XPOP(I,K,L),I=1,10)
 1006 FORMAT(' ',5X,'IF R=',F6.4,'  THEN X:',5X,10F8.4)
      WRITE(6,1007) R(K),(CXPOP(I,K,L),I=1,10)
 1007 FORMAT(' ',5X,'IF R=',F6.4,'  THEN 1-X:',3X,10F8.4/)
 0010 CONTINUE
 0009 CONTINUE
      DO 6 L=1,2
      WRITE(6,1003) NYEARS(L)
 1003 FORMAT(' ',///,30X,'REQUIRED RATE OF LABOR ABSORPTION
     X        '/,30X,'IF THE PLANNING PERIOD IS',
     X         I4,2X,'YEARS'//)
      DO 7 J=1,5
      WRITE(6,1004) P(J)
 1004 FORMAT(' ',//,10X,'IF P=',F5.3,' AND'/)
      DO 8 K=1,5
      WRITE(6,1005) R(K),(C(I,J,K,L),I=1,10)
 1005 FORMAT(' '12X,'R=',F6.4,10F10.4)
 0008 CONTINUE
 0007 CONTINUE
 0006 CONTINUE
 2000 CONTINUE
      STOP
      END
$GO
2
.25 .30 .35 .40 .45 .50 .55 .60 .65 .70
.50 .55 .60 .65 .70
.0208 .0218 .0228 .0238 .0248
5  10
.8 .9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7
.50 .55 .60 .65 .70
.0208 .0218 .0228 .0238 .0248
5  10
$$
//
```

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13. ABSTRACT

Present conditions indicate that there will be a severely dislocated and redundant labor force in the postwar South Vietnamese economy. This surplus is the result of abnormally rapid development of some industries which now must face radical changes and the refugees created by hostile activities. To achieve optimal growth, this pool of redundant labor must be reallocated to other sectors of the economy in which productivities are higher. The optimal division of labor after reallocation is estimated by a mathematical model as a function of several exogenous variables. This model also determines the required annual rate of labor absorption for the productive sectors if the reallocation effort is to be successfully completed in a given period of time and under the pressure of natural population growth. The presentation of results is in the form of a computer-based sensitivity analysis. Before reaching conclusions on the feasibility and validity of the results, dynamic programming techniques are suggested as a possible approach in using the reallocation model to forecast economic growth of the postwar South Vietnamese economy.

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